

and other property. At Socorro, on the 30th, a severe shower caused a flood, resulting in heavy damage to property and the loss of nine lives.

*New York.*—The month was cooler than usual, deficiencies in temperature occurring at all stations. The average temperature was 3.2° below the normal. The highest temperature was 98°, at South Kortright on the 20th, and the lowest, 36°, also at South Kortright on the 12th. Light frosts occurred in some highland valleys of the western and central sections on the 1st, 10th, and 11th. The precipitation was unevenly distributed over the State, but conformed in a general way to the normal. The average precipitation was 3.12. The heaviest general rainfall, exceeding 4.00, occurred over the coast region and in restricted portions of the northern highlands and the east-central counties; the least was less than 2.00, in the extreme west, and south of the central lakes. There were no severe general storms, but destructive wind and hail were reported from southeastern stations on the 12th and 13th.

*North Carolina.*—The month was cooler than the average, the mean temperature being 2.6° below the normal. The highest temperature was 99° at several stations from the 18th to 22d; the lowest was 43° at Linville on the 3d and 6th. The amount of rainfall was nearly normal, being deficient only 0.10. The greatest deficiency occurred in the west. The largest amount of rainfall, 9.03, was reported at Southport; the least, 2.32, at Asheville. Moderate thunderstorms occurred on all except 5 days during the month.

*North Dakota.*—The month was the coolest since the establishment of the State service in 1891, the mean temperature was 66°, or 5.5° cooler than July, 1894. The maximum temperature was 102° at Forman on the 5th, and the minimum, 29°, at Dickinson on the 29th. Heavy showers fell in all parts of the State from the 4th to 8th, after which there was an interval of light scattered showers until the 17th, when medium heavy ones fell in nearly all sections until the 23d, after which there were only light ones at widely separated places. There was a very severe storm at Grafton on the 14th, doing considerable damage and caused the death of a child. The average precipitation was 4.67, or about normal. The largest rainfall was 6.36, at Power, and the smallest, 0.95, at Ashley.

*Ohio.*—The mean temperature of the southern section was 73.4°; middle section, 70.9°; northern section, 70.1°; and of the State, 71.6°; these are below the averages for sections and State, 0.9°, 1.5°, 1.6°, and 1.2°, respectively. The maximum was 106° at Thurman on the 20th, and the minimum, 34°, at Auburn on the 9th, which is lower than any previous record. The average precipitation was 2.00; that for the southern section, 1.90; middle section, 2.12; and the northern section, 1.97; being below the normal for the State and sections by 1.12, 1.19, 1.16, and 1.03, respectively. Light frosts occurred in low-lying districts on the 4th and 10th; no damage.

*Oklahoma.*—The mean temperature was 79.2°, or 0.5° below the normal. The maximum temperature was 106° at Ponca on the 29th, and the minimum, 50°, at Pond Creek on the 7th. The average precipitation was 5.58, or 1.76 above the normal. The greatest amount, 11.75, occurred at Kemp, and the least, 1.55, at Ponca.

*Oregon.*—Both heat and moisture were about normal, the temperature slightly below and the precipitation a trifle above. The greatest departure from the normal temperature was in the eastern section, where it amounted to 2.3°. In the Willamette Valley and the southern portion the temperature was normal. The maximum was 107° at Pendleton on the 23d, and the minimum, 21°, at Burns on the 6th. There was more rain than usual in the Willamette Valley and the coast district, while in the southern and eastern portions there was less, the excess in the coast district amounting to nearly half an inch. The average rainfall was 0.55, or 0.09 above the normal.

*Pennsylvania.*—The average temperature, 69.1, was 1.9° below the normal for the past seven years. The highest temperature was 102° at (Aqueduct) Logania on the 20th, and the lowest, 34°, at Shinglehouse on the 2d. The average precipitation was 3.24, or 0.97 less than the usual amount. The largest amount was 6.18 at Confluence, and the smallest, 1.16, at Harrisburg. Thunderstorms were frequent. Hail was reported on the 5th, 16th, 20th, 21st, and 27th, and frosts on the 4th, 10th, 11th, 13th, 14th, 30th, and 31st.

*Rhode Island.*—(See *New England*.)

*South Carolina.*—The month was much cooler than usual during the first seven days, and about normal or warmer during the remainder of the month. The mean temperature, 79.5°, averaged about normal.

The maximum, 102°, was reported at Gillisonville on the 17th, and the minimum, 54°, at Spartanburg on the 10th. The rainfall averaged 69 per cent of the usual amount and was not well distributed. The average was 4.17, or 1.85 below the normal. The greatest amount, 8.50, was recorded at Georgetown, and the least, 0.73, at Cheraw. Thunderstorms were quite frequent.

*South Dakota.*—The mean temperature, 70.8°, was 0.7° below the normal. The highest temperature was 111° at Cherry Creek on the 4th, and the lowest, 27°, at Forest City on the 10th. The average precipitation was 1.60, or 1.33 below the normal. The largest amount, 3.79, was recorded at Brookings, and the smallest, 0.39, at Rapid City. Thunderstorms were frequent. Some stock was killed by lightning on the 17th in Deuel County and on the 20th in Jerauld County. Hail was reported on the 9th, 14th, 18th, 26th, 28th, 29th, and 31st. The hail in a portion of Day County on the 26th was said to be the size of a hen egg.

*Tennessee.*—The month presented some quite abnormal features, the principal of which were the large monthly rainfall and the low temperatures which prevailed during the first and third decades. The average temperature was 75.9°, or slightly below the normal. The 18th and 26th were the only days on which no precipitation was recorded at any of the stations. The average amount was 6.48, or 2.19 more than normal.

*Texas.*—The mean temperature was 0.4° below the normal. It was below the normal everywhere except over the southwest portion and extreme western portion of the coast district, where there was an excess ranging from 0.7 to 2.3°. The average precipitation was 0.42 above the normal. It was above the normal over north, central, west, and east Texas, and the eastern portion of the coast district, while over other portions of the State there was a general deficiency ranging from 0.88 to 2.14.

*Utah.*—The mean temperature was 70°, or about 3° below the normal. The maximum was 110° at Fillmore on the 10th, and the minimum, 33°, at Loa on the 11th. The average precipitation was 0.57; greatest total amount was 2.29 at Grover, and the least, a trace, at Deseret. Thunderstorms were frequent. Hail was reported on the 9th, 10th, 11th, 17th, and 29th. Light frost was reported at Heber on the 1st, 6th, 23d, and 24th, and at Grover on the 12th and 13th.

*Vermont.*—(See *New England*.)

*Virginia.*—The month opened with moderate temperatures generally in all sections, but a slow rise prevailed until the 9th, when the temperature declined; it remained moderate until the 14th, when it began to rise and a heated period of ten days followed. From the 24th to the end of the month the temperature remained about normal. The total precipitation was slightly below the normal. It was heaviest in the Blue Ridge counties, and, with few exceptions, lightest in the tidewater counties. Fairly heavy showers occurred on the 1st-2d, 7th, 16th, 23d, 25th, and 31st, and light showers 9th to 14th, 19th to 21st, and 27th to 30th.

*Washington.*—The chief characteristics during the month were a very uniform temperature slightly below the normal and a rainfall also considerably below the average, with hot dry winds in the eastern section.

*West Virginia.*—The mean temperature was about 3° below the normal. The month was characterized by extremes of heat and cold. From the 1st until the 16th the temperature was below normal every day but two, the 7th and 8th; from the 18th to the 22d a period of intense heat occurred, followed by cool weather until the close of the month. Light frosts were reported on the 31st from some elevated districts. The rainfall was very nearly normal, but was quite unevenly distributed, the southern section receiving more than the average and the northern section less. Hail was reported at White Sulphur Springs on the 2d and at another station on the 27th.

*Wisconsin.*—The mean temperature was 68.7°, only 0.2° above the normal. The highest temperature was 100° at Pepin on the 6th, Black River on the 5th and 6th, and Prairie du Chien on the 7th, and the lowest, 33°, at City Point on the 31st. Frosts occurred in the northern portion on the 7th, 8th, 9th, and 31st. The average rainfall was 2.47, or 0.42 below the normal. The extreme southern portion of the State received little or no rain, while over the northern portion the amount received was fully up to the average and well distributed.

*Wyoming.*—The mean temperature was 64°, being decidedly below the normal. The highest temperature was 101° at Wheatland on the 27th, and the lowest, 28°, at Wise on the 7th. The average amount of precipitation was 2.71, or slightly in excess of the normal.

## STUDIES BY FORECAST OFFICIALS.

### HIGH AREAS OF THE NORTH PACIFIC COAST IN SEPTEMBER, OCTOBER, AND NOVEMBER.

(By Prof. E. B. GARRIOTT; dated September 13, 1893.)

The high areas of the North Pacific Coast in September, October, and November are associated with low areas which occupy the north-central districts of the United States. Low

areas of this type usually move eastward over, or north of the Great Lakes, and are seldom attended by precipitation south of the Ohio River and the more northern of the Middle Atlantic States (see Charts VI, VII, and VIII). With the eastward movement of a low area from the north-central districts the high area on the North Pacific Coast moves east-

southeastward attended by marked changes in temperature from the middle-eastern and northeastern slopes of the Rocky Mountains over the Missouri and upper Mississippi valleys and Lake Region. When a high area appears on the North Pacific Coast, and the low area is located over or east of the Great Lakes, a secondary disturbance generally develops over the central valleys. If a high area appears on the North Pacific Coast and a low area is not shown in the Northwest, one will probably develop within twelve hours.

The Pacific Coast high areas of September advance to the upper Mississippi Valley in about seventy-two hours at an average velocity of about 21 statute miles per hour. During that period the low areas which appear in the Northwest pass eastward over the northern Lakes and reach Newfoundland traveling at an average velocity of 28 miles per hour. In September, when the pressure rises above 30.20 on the North Pacific Coast and falls below 29.80 between Lake Superior and the upper Missouri Valley, rain may be expected within an area extended from the western Lakes over the extreme upper Mississippi Valley in twenty-four hours; over the middle, southern, and eastern Lake Region in thirty-six hours; and over New York, northeastern Pennsylvania, northern New Jersey, and New England in forty-eight hours. A temperature fall of 10° or more will probably be experienced on the northeast slope of the Rocky Mountains and over the western half of the Dakotas in twenty-four hours; from the eastern half of the Dakotas over the extreme upper Mississippi Valley and western Lake Superior in thirty-six hours; and over the Lake Region in forty-eight hours. Occasionally a September high area will appear on the North Pacific Coast showing pressure above 30.20, with a rather weak low area over or north of the upper Missouri Valley. The high area will remain nearly stationary for a period of one, two, or three days, with increasing pressure, and the low area will gradually deepen. When the low has gathered sufficient strength to overcome the obstruction (generally a high area to the eastward) which has prevented its eastward advance the eastward movements of the high and low areas begin. In such cases the low area generally increases in intensity as it passes over the Great Lakes. Again, a deep low area will appear in the Northwest and remain nearly stationary for several days, while the pressure gradually increases over the North Pacific Coast Region. When the pressure on the North Pacific Coast reaches 30.20 an eastward movement of the high and low areas may be expected. In cases where the pressure does not rise to 30.20 on the North Pacific Coast the low area in the Northwest will dissipate.

In October the movements of the high and low areas are somewhat more rapid than for the preceding month. The high areas from the North Pacific Coast advance to the middle Ohio Valley in seventy-two hours and the low areas traverse a path extending from the one hundredth meridian to a point

southeast of Newfoundland in the same period of time. In October, when the pressure rises to 30.20 or above on the North Pacific Coast and falls to or below 28.80 in the Northwest, rain or snow may be expected over the Red River of the North Valley, over the extreme upper Mississippi Valley, and the northwestern Lake Region in twenty-four hours; in the Lake Region and upper Mississippi and northern Ohio valleys in thirty-six hours, and in the Middle Atlantic and New England States in forty-eight hours. The temperature will probably fall 10° or more in the middle and upper Missouri valleys in twenty-four hours; over the Red River of the North Valley, over the extreme upper Mississippi Valley and the western Lake Region in thirty-six hours, and over the central and eastern Lake Region and the interior of Pennsylvania, New York, and New England in forty-eight hours.

In November there is a marked change in the character of the high areas that appear over the northwestern part of the United States. In that month a majority of the high areas advance from the British Northwest Territory and enter the region of observation on the northeast slope of the Rocky Mountains. The high areas that advance from the North Pacific Coast often settle southeastward and become a part of the permanent high that commences to build up over the middle plateau region with the advent of the colder months. Many of the high areas that appear over the British Northwest Territory show pressure above 30.50 and sometimes 30.70 and 30.80. High areas of this class often extend westward over the North Pacific Coast. This class of high areas is not considered in the present paper.

In November, when a high area appears on the North Pacific Coast with a low area east of the ninetieth meridian, rain or snow will probably fall in New England within twenty-four hours. When high areas advance from the British Northwest Territory the preceding low areas are seldom attended by precipitation west of the Great Lakes. When the pressure on the North Pacific Coast rises to or above 30.30 and falls to or below 29.80 in the Northwest, precipitation may be expected in the middle and upper Missouri and extreme upper Mississippi valleys and the upper Lake Region in twenty-four hours; in the lower Lake Region, New York, and northern Pennsylvania in thirty-six hours, and from the eastern Lakes over the Middle Atlantic and New England States in forty-eight hours. The temperature will probably fall 10° or more over the Missouri Valley, and the extreme upper Mississippi Valley, in twenty-four hours; in the upper Lake Region and the upper Mississippi and lower Ohio valleys in thirty-six hours, and from the lower Lake Region over the interior of the Middle Atlantic and New England States in forty-eight hours.

[NOTE.—Three charts, Nos. VI, VII, and VIII, accompanied the preceding article and are reproduced herewith.]

## SPECIAL CONTRIBUTIONS.

### THE MARVIN SEISMOGRAPH.

By Prof. C. F. MARVIN, U. S. Weather Bureau.

A seismograph is an instrument that produces an automatic record of tremblings, oscillations, vibrations, or quakings of the crust of the earth. In the most complete seismograph the precise time at which the event takes place and the exact nature and extent of the motions of the earth particle, that is, the portion of the surface supporting the instrument, are all faithfully recorded, but the name is also frequently and properly applied to instruments that record perhaps no more than one of the elements mentioned above, or even simply the time of occurrence of the tremors.

The rumbling of a cart or wagon along a roughly paved roadway near at hand, the passage of a train at a distance, or a remote and violent explosion, all produce tremors in the earth that differ from actual earthquakes, properly so-called, in intensity and violence. With little difficulty instruments can be constructed that will faithfully record even the feeblest of these tremblings.

Small seismic disturbances, or earthquakes, are frequent even in the eastern portion of the United States, and geologists are interested in the systematic observation of such phenomena. The very considerable cost and the great delicacy of instruments for automatically registering all the fea-